

# 1.0 INTRODUCTION

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## 1.1 BACKGROUND

On April 9, 1998, at approximately 11:28 pm, an 18,000-gallon propane tank exploded at the Herrig Brothers Feather Creek Farm (the farm) in Albert City, Iowa. The blast occurred less than half an hour after an all-terrain vehicle (ATV), driven by a minor without the owner's permission, damaged two aboveground propane pipes and a fire resulting from that accident engulfed the tank. The explosion that occurred at the farm is known as a Boiling Liquid Expanding Vapor Explosion or BLEVE.<sup>1</sup> Tank fragments produced by the BLEVE killed two volunteer fire fighters.<sup>2</sup> In addition, seven other emergency response personnel were injured, and several buildings were damaged by the blast. The arrow in Figure 1 points to the location of the tank prior to the blast.



**Figure 1. Aerial View of the Farm on April 10, 1998**

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<sup>1</sup> A BLEVE can occur when “a pressure vessel containing a flammable liquid like a propane tank is exposed to fire so that the metal loses strength and ruptures.” Lees, Frank P. *Loss Prevention in the Process Industries: Hazard Identification, Assessment and Control*, 2<sup>nd</sup> ed.; Butterworth-Heinemann: Oxford, England; 1996, Vol. 2, 17/177. For further discussion of BLEVEs, see section 3.3.

<sup>2</sup> In recent years, six other fire fighters have been killed in BLEVE incidents on farms. Duval, Robert. *Fire Fighter Fatalities Albert City Iowa April 9, 1998*; National Fire Protection Association: Quincy, MA, 1999; 27.

## 1.2 INVESTIGATION PROCESS

The scope of the investigation was to determine the root and contributing causes of the deaths and injuries to emergency response personnel. The investigation focused on the design and installation of the propane storage and handling system at the farm, state regulatory oversight of that and similar installations, and the fire fighter response to this incident. The ultimate objective of this investigation was to develop recommendations to help prevent similar incidents.

The investigation team conducted material and structural analyses to estimate what the pressure was when the tank ruptured, as well as failure mode and effects analysis to confirm that a BLEVE caused the tank's failure. Investigators identified deficiencies in the design of the propane storage and handling system. A NASA laboratory, the Kennedy Space Center Materials Science Division, performed an incident reconstruction analysis to determine why an excess flow valve<sup>3</sup> protecting an aboveground liquid propane pipe failed to activate. A certified fire investigator from the Department of the Treasury's Bureau of Alcohol, Tobacco and Firearms examined tank fragments for evidence of significant flame patterns. Further discussion of the methodologies and test results used to determine the causes of the BLEVE is contained in Appendix A.

The U. S. Chemical Safety and Hazard Investigation Board (CSB) greatly appreciates the contribution of the following organizations which provided information or other assistance with respect to this investigation: Kennedy Space Center Materials Science Division; Department of the Treasury's Bureau of Alcohol, Tobacco and Firearms; Oak Ridge National Laboratory; the Iowa Labor Services Division<sup>4</sup>; Iowa State Fire Marshal's Office; Buena Vista County Sheriff's Department; National Fire Protection Association; and J.L. Hall Engineering Services, P.C.

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<sup>3</sup> An excess flow valve is designed to greatly reduce the flow of liquid from a pipe that is damaged in such a fashion that flow through the line exceeds a predetermined flow rate. For a detailed discussion of excess flow valves, see section 4.1.2.

<sup>4</sup> Since the incident, the Iowa Labor Services Division has conducted a series of workshops for emergency responders which have included a discussion of lessons learned from this incident.